The Higher the Station, the More Its Sea-Level Pressure Is an Assumption

— an error of **1** K in the assumed summit temperature moves Fuji's sea-level pressure by **1.735462** hPa, against only **0.010426** hPa at a lowland station of **25** m — exchanging one formula for another moves it by only **0.317313** hPa — [Paper 569]

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— *From thinking to syncing.* —

Abstract

Weather maps draw pressure reduced to sea level.What this paper shows is that at a mountain station the column of air down to sea level does not exist, so its temperature can only be assumed, and the higher the station, the larger the share of the reduced value that is assumption.No new theorem or law is claimed. First, the formula itself checks——the exponent $g/(R\Gamma) = 5.255932$ matches the known 5.2559, and a standard-atmosphere summit value reduces back to exactly 1013.25 hPa (Section 2). **Second, one observation moves by seventy hectopascals with the assumption——640 hPa at the summit becomes 1060.9396 hPa at an assumed 243.15 K and 990.6770 hPa at 283.15 K** (Section 3). **Third, and this is the core.The effect of a 1 K error grows with the height of the station——0.010426 in the lowland, 0.427129 at 1000 m, 1.735462 hPa at the summit** (Section 4). **Fourth, the summit exceeds the lowland over 160-fold——the same one-kelvin error tells two orders differently according to the station's height alone** (Section 4). **Fifth, the assumed temperature outweighs the choice of formula——two formulas differ by 0.317313 hPa, under a fifth of the effect of one kelvin** (Section 5). **Sixth, the separator is whether the station stands at the height reported——at zero elevation the correction is exactly zero and no assumption enters** (Section 5).
Keywords: reduction to sea level, atmospheric pressure, temperature lapse rate, hypsometric equation, standard atmosphere.

Scope of this paper (scope note): **No new theorem or law is claimed——the pressure formula for a constant lapse rate and the hypsometric equation are standard.Procedures of meteorological services are not discussed——the detailed reduction rules of national services, such as how temperatures are averaged or humidity handled, are left aside; only the general form is examined.The lapse rate is constant——a fixed 0.0065 K/m is used, without inversions or surface heating.Humidity is excluded——no virtual temperature is used; the air is taken as dry.The summit temperatures are illustrative——the range 243.15 to 283.15 K is a span for testing sensitivity, not a claim about Fuji's climate.Instrument error is excluded——only the assumption is varied.It is not said that reduced values are meaningless——placing stations of different heights on one map requires reduction; what is said is only that assumptions weigh more at higher stations.Relation to earlier papers**: **Paper 321 showed that the length that sets how thick an atmosphere is also sets whether it stays——the same pressure law, but that paper asks what the length $H = kT/(mg)$ decides, while this one asks what happens when that T must be assumed for a column that does not exist.Paper 349 showed that a mirage needs temperature rising with height——the same 5.2559 appears there as the ratio of the pressure term to the temperature term in refraction: one number, another role.Paper 527 showed that multiplying the Earth's radius by $4/3$ is a convention, and that there are two of them——two formulas stand side by side here as well, but their difference of 0.317313 hPa is a minor part; what tells is not the convention but the assumed input.Paper 300 showed that sharing a root is decidable——"the correction grows with height" and "the effect of the assumption grows with height" share one root, the length of a column that is not there.**What is added is **matching the exponent to its known value and confirming the standard-atmosphere round trip to 1013.25 hPa**, **reducing one observation at five assumed temperatures and measuring a movement above 70 hPa over 40 K**, **setting out the effect of one kelvin at three heights and showing the summit exceeds the lowland over 160-fold**, **comparing the choice of formula against the effect of temperature**, and **placing the separator on whether the station stands at the height reported**.

1. Notation and the Question

Setting: **a pressure P measured at a station of elevation h is reduced to a sea-level value P_0.For an atmosphere whose temperature falls with height at a constant rate Γ,**

$$P_0 = P\left(1 + \frac{\Gamma h}{T_s}\right)^{g/(R\Gamma)}$$

with T_s the station temperature and R the gas constant for dry air.

Observation 1.1

beneath a mountain there is no column of air down to sea level.There is rock——the formula imagines a column that does not exist and adds its weight.

> **Observation 1.2**
>
> **so the column's temperature can only be assumed.It is built from the station temperature by assuming a constant lapse rate——if the assumption is off, so is the weight added.**

Question: **how much does the assumed temperature move the reduced value?And how does that depend on the height of the station?**

2. Checking the Formula Itself

Computation 2.1: **with $g = 9.80665$, $R = 287.05$ and $\Gamma = 0.0065$ K/m, the exponent is $g/(R\Gamma) = \mathbf{5.255932}$.**

> **Observation 2.2**
>
> **it matches the known value.Within 10^{-4} of the 5.2559 known for the standard atmosphere——a comparison with a value from outside.**

Computation 2.3: **the standard-atmosphere pressure and temperature at the summit of Fuji (3776 m), reduced back to sea level.**

quantity	value
standard summit pressure	**634.606842** hPa
standard summit temperature	**263.6060** K
reduced to sea level	**1013.250000000** hPa

> **Observation 2.4**
>
> **the round trip returns exactly.With the right assumption, the formula is correct to 10^{-9}——the formula is sound; what matters is the temperature put into it.**

Observation 2.5

the boundary was checked.At zero elevation the correction is exactly zero, to 12 digits——measure at sea level and nothing is added.

3. One Observation, Moved by an Assumption

Computation 3.1: **taking 640 hPa observed at the summit and reducing it under different assumed summit temperatures.**

assumed summit temperature	reduced (power law)	reduced (mean-temperature form)
243.15 K	**1060.9396** hPa	**1060.5268** hPa
253.15 K	**1040.8984** hPa	**1040.5375** hPa
263.15 K	**1022.6540** hPa	**1022.3367** hPa
273.15 K	**1005.9775** hPa	**1005.6970** hPa
283.15 K	**990.6770** hPa	**990.4279** hPa

Observation 3.2

one observation moves by more than seventy hectopascals.Over 40 K, above 70 and below 71——the barometer reads the same 640 hPa, and the value drawn on the map shifts by over seventy with the assumption.

Observation 3.3

assuming warmer lowers the reduced value.A warmer column is lighter and adds less weight——monotonically, reversing nowhere.

4. The Effect of One Kelvin Depends on Height

Computation 4.1: **at three stations, the movement of the reduced value for a 1 K error centred on the standard-atmosphere temperature.**

station	correction	movement for 1 K
lowland (25 m, 1010 hPa)	2.9990 hPa	**0.010426** hPa
1000 m (900 hPa)	114.6654 hPa	**0.427129** hPa
summit of Fuji (3776 m, 640 hPa)	381.8610 hPa	**1.735462** hPa

> **Observation 4.2**
>
> **this is the core.The same one-kelvin error gives 0.010426 hPa in the lowland and 1.735462 hPa at the summit——the summit above 1.7 and below 1.8, the lowland above 0.010 and below 0.011, each measured before being bracketed.**

> **Observation 4.3**
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> **the summit exceeds the lowland over 160-fold.Above 160 and below 170——the same error in the assumption tells two orders differently by the station's height alone. A lowland reduced value is nearly an observation; a summit reduced value holds a great deal of assumption.**

> **Observation 4.4**
>
> **the effect grows monotonically with height.The longer the absent column, the more is assumed about it——the correction itself rises through 2.9990, 114.6654 and 381.8610 hPa, exceeding a third of the final value at the summit.**

5. The Separator

Computation 5.1: **compared with exchanging the formula: at the summit and 263.15 K, the power law and the mean-temperature form differ by 0.317313 hPa (above 0.30 and below 0.35).**

Observation 5.2

the assumed temperature outweighs the choice of formula.One kelvin of error moves 1.735462 hPa; exchanging formulas moves 0.317313——the first exceeds the second more than fivefold. The assumed input weighs more than the convention of which formula to use.

Observation 5.3

the separator is whether the station stands at the height reported.Measured at sea level, the correction is exactly zero and no assumption enters——when a value is measured high and reported low, assumption fills the gap. Measured values and computed values containing assumptions stand on one map in one unit.

Observation 5.4

a different question from Paper 321.There the length $H = kT/(mg)$ was shown to set an atmosphere's thickness and its escape——here the same T must be assumed for a column that does not exist. There T is a property of the atmosphere; here it is an assumption placed by the observer.

Observation 5.5

the same 5.2559 appears in Paper 349.There it is the ratio of the pressure term to the temperature term in refraction——one $g/(R\Gamma)$ acting as a ratio of terms in a mirage and as the exponent of a reduction here. One number, another role.

Observation 5.6

a different weight from Paper 527.There two conventions for one atmosphere disagreed by 1.077033, and that disagreement was the subject——two formulas stand here too, but their difference is minor. What tells is not the convention but the assumed input.

> **Observation 5.7**
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> **one root, under Paper 300.“The correction grows with height” and “the effect of the assumption grows with height” both come from the length of an absent column——set the height to zero and both vanish.**

6. Roll Call and Closing

1. **exponent 5.255932** (Computation 2.1): **matching the known 5.2559.**
2. **standard round trip, 1013.250000000** (Computation 2.3): **the formula is sound.**
3. **one 640 hPa from 1060.9396 to 990.6770** (Computation 3.1): **over seventy apart.**
4. **lowland, 0.010426 hPa per kelvin** (Computation 4.1): **nearly an observation.**
5. **summit, 1.735462 hPa per kelvin** (Computation 4.1): **the core.**
6. **summit over 160 times the lowland** (Observation 4.3): **two orders apart.**
7. **formula difference 0.317313 hPa** (Computation 5.1): **a minor part.**
8. **temperature over five times the formula** (Observation 5.2): **assumption outweighs convention.**
9. **the separator is standing at the reported height** (Observation 5.3): **zero elevation, zero assumption.**
10. **the same 5.2559 in Paper 349** (Observation 5.5): **one number, another role.**

Closing: **Weather maps draw pressure reduced to sea level.At a mountain station, however, the column of air down to sea level does not exist——there is rock beneath, and the reduction adds the weight of a column that is not there, so its temperature can only be assumed. The formula itself is sound: its exponent 5.255932 matches the known 5.2559, a standard-atmosphere summit value reduces back to exactly 1013.25 hPa, and zero elevation gives exactly zero correction.What matters is the temperature put into it——640 hPa observed at the summit becomes 1060.9396 hPa under an assumed 243.15 K and 990.6770 hPa under 283.15 K, moving over seventy hectopascals across 40 K. The effect of one kelvin grows with height, 0.010426 hPa in the lowland, 0.427129 at 1000 m and 1.735462 at the summit, the summit exceeding the lowland over 160-fold. A lowland reduced value is nearly an observation, while a summit reduced value holds a great deal of assumption, its correction alone exceeding a third of the final value.The assumed temperature outweighs the choice of formula——the power law and the mean-temperature form differ by 0.317313 hPa, under a fifth of one kelvin’s effect. The input weighs more than the convention.The separator is whether the station stands at the height reported——measured at sea level, no assumption enters; measured high and reported low, assumption fills the gap, and measured values and computed values containing assumptions stand on one map in one unit. Under Paper 300 the growth of the correction and the growth of the assumption’s effect share one root, the length of an absent column.Placed among the earlier papers ——Paper 321 showed what the length $H = kT/(mg)$ decides, its T a property of the atmosphere, while here T is an**

assumption placed by the observer. Paper 349 carries the same 5.2559 as a ratio of terms in refraction, one number in another role. Paper 527 made two conventions its subject, while here two formulas differ only slightly and the assumed input is what tells.To be honest——the reduction rules of meteorological services were not discussed. The lapse rate was held at 0.0065 K/m, humidity excluded with the air taken as dry, and the summit temperatures are an illustrative span rather than a claim about Fuji's climate. Instrument error was left out. Nor are reduced values called meaningless: placing stations of different heights on one map requires them, and what is said is only that assumptions weigh more at higher stations.

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